

**Before the  
Federal Communications Commission  
Washington, D.C. 20554**

In the Matter of	)	
	)	
Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies	)	ET Docket No. 03-108
	)	
Authorization and Use of Software Defined Radios	)	ET Docket No. 00-47
	)	(Terminated)
	)	

**COMMENTS OF NOKIA INC.**

**Introduction**

Nokia Inc. (“Nokia”) hereby submits these comments in response to the *Notice of Proposed Rulemaking and Order*<sup>1</sup> in the above-captioned proceeding. Nokia is the world leader in mobile communications. The company is the leading supplier of mobile phones and a leading supplier of mobile, fixed broadband and IP networks. Nokia is a broadly held company with listings on six stock exchanges.

Nokia supports the ongoing efforts of the Federal Communications Commission (“Commission”) to update and review spectrum management policies with the goals of increasing access to and use of spectrum, while promoting efficiency and reliability in spectrum use. Nokia applauds the Commission’s efforts to facilitate the deployment of new technologies where they are found to facilitate these spectrum management goals.

**Discussion**

The Commission states that among the capabilities that can be incorporated into cognitive radios are frequency agility or dynamic frequency selection (“DFS”), adaptive modulation, transmit power control (“TPC”), location determination, and a mechanism that enables spectrum sharing under the terms of an agreement between a licensee and a third party. These capabilities would enable a cognitive radio to change its transmitter parameters in response to the environment in which the radio is operating. It should be noted that some of these capabilities already exist in today’s licensed and unlicensed networks. For example, Commercial Mobile Radio Service

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<sup>1</sup> *Facilitating Opportunities for Flexible, Efficient, and Reliable Spectrum Use Employing Cognitive Radio Technologies*, ET Docket No. 03-108, (rel. December 30, 2003) (NPRM and Order).

("CMRS") networks, such as those in the cellular and Personal Communications Service ("PCS") bands, use DFS and TPC to improve spectrum efficiency. The Commission's current rules have not hindered the deployment of these basic cognitive radio technologies.

The Commission lists four scenarios in which cognitive radios could improve spectrum access and efficiency of spectrum use: (1) a licensee can employ cognitive radio technologies internally within its own network to increase the efficiency of use, (2) cognitive radios can facilitate secondary markets in spectrum use, implemented by voluntary agreements between licensees and third parties, (3) cognitive radio technologies can facilitate automated frequency coordination among licensees of co-primary services and (4) cognitive radio technologies can be used to enable non-voluntary third party access. As noted above, CMRS networks already deploy some cognitive radio technologies to enable a network to improve its own internal efficiency. As cognitive radio technologies become more advanced, it is expected that they will continue to increase a network's abilities to operate more efficiently and gain additional capacity.

Applying cognitive radio technologies to unlicensed devices to enable non-voluntary third party access has proven to be more difficult as the experience with wireless local area networks ("WLAN") in the 5GHz frequency band has shown. The sharing etiquette in the 5GHz band that is intended to enable sharing between U-NII devices and radars took a considerable amount of time and efforts to develop and negotiate. This solution was crafted for a particular band and a particular set of services. It is our belief that blanket regulations are not the best mechanism for promoting sharing. Rather where it is determined that sharing between services is feasible and desirable, the sharing solution should be negotiated between the interested parties in that band with the particular environment of that band in mind in order to achieve optimum spectrum use.

The concept of using cognitive radio technologies to enable non-voluntary third party sharing must take into consideration the costs as well as the benefits. Use of cognitive radios that are truly capable of allowing unlicensed devices to opportunistically exploit times or locations where licensed services are not using their spectrum "fully" is likely lead to increased cost and complexity for both licensed and unlicensed devices in the near-term.

Implementing advanced cognitive radio technologies, which are not fully mature or tested, as an interference management technique risks introducing unacceptable levels of interference into licensed bands. In the case of mobile networks that are particularly susceptible to interference, the negative impacts include reduced network coverage and capacity as well as a negative impact on price, size and power consumption of equipment. The

increased costs and potential of reduced quality and reliability of service should be carefully weighed against the potential benefits. It is our belief that it is too soon to attempt to base new spectrum management policies, such as unlicensed “underlays” or “interference temperature” on these technologies without further study and consideration. As we have said in the Interference Temperature proceeding<sup>2</sup> and other proceedings before the Commission, technology alone cannot be a panacea for good spectrum management policy.

### **Rural Markets and Unlicensed Devices**

The Commission proposes adding a new rules section that would apply to cognitive radio devices operating in the industrial, scientific and medical bands on frequencies identified in Section 15.247 and 15.249 of the rules. This new rule would allow a transmitter power increase of up to six times higher than current limits for both in-band and out-of-band emissions. Nokia believes that promoting wireless services in rural areas is a worthy goal, but we also believe this proposal requires further study. There is significant potential for unlicensed devices operating at higher power levels to increase both in-band and out-of-band interference to licensed networks such as CMRS, particularly if they are deployed ubiquitously. This increased interference could result in lost coverage and reduced network capacity for licensed networks such as CMRS, particularly at the edge of these licensed networks where it is anticipated that areas of “limited spectrum use” would exist. Mobile networks are more vulnerable to interference than other systems due in part to their wide-coverage areas.

The Commission proposes that unlicensed devices be permitted to operate at higher power levels in areas with “limited spectrum use” which is defined as “spectrum with a measured aggregate noise plus interference power no greater than 30 dB above the calculated thermal noise floor within a measurement bandwidth of 1.25 MHz which is the same as specified for unlicensed PCS use”.<sup>3</sup> The Commission proposes that unlicensed devices must be able to sense across the entire band of operation to determine spectrum occupancy before commencing operations. This seems to be a variation on the interference temperature concept proposed in the Commission’s earlier NOI and NPRM on the Establishment of an Interference Temperature Metric. This is a costly requirement for unlicensed devices that typically require low costs and relatively simple design for market success. Both the definition of limited spectrum use and the method for unlicensed devices determining the level of spectrum use in a given location require further study. This proposal is not ready for implementation at this time.

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<sup>2</sup> *Establishment of an Interference Temperature Metric to Quantify and Manage Interference and to Expand Available Unlicensed Operation in Certain Fixed, Mobile and Satellite Frequency Bands*, ET Docket No. 03-237, (rel. November 28, 2003) (NOI and NPRM).

## Secondary Markets

The Commission notes that cognitive radios could incorporate mechanisms to enable voluntary spectrum leasing transactions between licensees and potential lessees that would otherwise not be possible, thus making a greater range of spectrum leasing opportunities available. Nokia supports the Commission's efforts to explore additional mechanisms to facilitate secondary markets.

One of the methods described by the Commission as a potential technical approach is a "beacon" system whereby a lessee's transmitter must have the ability to receive a control signal sent continuously by the licensee at times when transmissions by the lessee are permitted. The lessee cannot begin transmissions if the beacon signal is not received and if the beacon signal ceases while the lessee is transmitting, transmissions must cease within a specified time interval. The beacon approach requires adequate signal coverage. This is challenging due to the wide-areas coverage networks in rural areas and the radio propagation characteristics and other factors resulting in increased congestion/interference in urban or suburban areas. The best solutions to these problems are to build a denser beacon network or utilize more advanced receiver and communication technologies. Both options entail additional costs for the licensee and lessee, which mean that beacon systems may not be available at a "reasonable cost and acceptable complexity to implement and maintain."<sup>4</sup>

## Summary

Basic cognitive radio technologies are a part of existing licensed and unlicensed networks. Cognitive radios have already been successfully deployed to help today's systems gain the maximum capacity and spectrum efficiency out of their own systems within their own spectrum. The existing rules have supported this deployment and do not require significant changes.

While cognitive radio technologies are being used in their more basic forms, we recommend that the Commission take a cautious approach to relying on cognitive radios as the means to enable more advanced solutions to spectrum sharing and use. Further study is required to fully understand the reliability and costs of cognitive radios, particularly in the area of permitting non-voluntary spectrum sharing. Rules should not be written for more

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<sup>3</sup> *NPRM and Order*, ¶144.

advanced technologies before they are well-understood. As cognitive radios become a more mature technology and appropriate rules are developed to facilitate their deployment, these rules should be tailored to specific bands and services. General rules for cognitive radios will not facilitate the most efficient use of spectrum.

Nokia is pleased to see the Commission review current spectrum management policy to address current and future challenges. We support the Commission's efforts to evaluate creative approaches to solve these problems. We respectfully ask that the Commission consider our comments on this proceeding.

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<sup>4</sup> *Id.*, ¶58.